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ABSTRACT

The paper reports on a two-part longitudinal study of the English language competencies of deaf students for whom total communication through manual coded English (MCE) was the primary method of instruction. In Part I of the study, the performance of three groups of deaf Ss who used MCE was compared with that of three groups of normal hearing Ss who used oral English. In Part II of the study, a subset of Ss from the original sample were retested 3 years later and those scores compared with their original scores. Analysis of scores on a modified version of the Imitation, Comprehension, and Production (ICP) test demonstrated deficits experienced by deaf Ss during the early stages of language acquisitions (a language difference with hearing Ss on such an ICP task was 3-4 years). However, the results also showed the long term improvement toward mastery of basic English grammar possible with MCE instruction in total communication programs. Additional findings pointed to a pattern of difficulty in the acquisition of the ICP's 12 grammatical features by deaf Ss. (CL)

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Effects of Instruction Through Total Communication On Deaf Children's English Language Development

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Effects of Instruction Through Total Communication

On Deaf Children's English Language Development

Total Communication (TC) is an instructional philosophy which was implemented recently in education of the hearing impaired. It has subsequently been adopted for instruction of other special populations as diverse as learning and physically disabled. TC promotes an eclectic instructional methodology with options for use of standard oral instructional techniques, emphases on print and visual media and, more controversially, the use of manual communication systems. With alternatives available, successful communication strategies could be derived in accord with different situational requirements, in particular, the receptive and expressive abilities of the interactors (Cokely, 1979). It was theorized that providing means for effective communication, through the unimpaired visual/manual modalities, would enhance the educational achievement of prelingually deafened children, the majority of whom have hearing parents.

In a narrower perspective TC was implemented as a means to improve language acquisition by deaf learners. This objective reflected both the importance of language to all aspects of life, and the long-standing English language deficits of the deaf population (Moores, 1970). Adoption of the TC approach was made possible by the development of manually coded English (MCE). Systems of MCE were devised to provide symbols for semantic and syntactic features of English in a manual format. Vocabulary signs for English words were taken from American Sign Language (ASL). Then, to provide signed elements for English function words and grammatical inflections, new

sign elements were contrived. Through manual English, it was believed, deaf children could experience a reasonable facsimile of the English language environment available to normal hearing children. Acquisition of English could thus be expected to proceed in more normal fashion for the deaf child. Implicit in these beliefs were assumptions 1) that visual/manual channels have the same ultimate capacity to serve (English) language functions as do aural/oral channels, 2) that manual and oral English can be learned through similar processes (e.g., hypothesis testing), and 3) that oral and manual English result in similar types and degrees of interactive constraints for the language user (e.g., speed/accuracy). Manual English systems have been criticized by linguists with respect to these assumptions (Charrow, 1975) as well as for apparent violation of the formational regularities of American Sign Language in the development of contrived signs (Battison, 1974).

Studies of TC completed to date have demonstrated a positive relationship between TC and academic achievement (Chasen and Zuckerman, 1976) and compared TC favorably with oral only and Visible English (fingerspelling) programs (Weiss, et al., 1975). The importance of parental use of MCE in promoting English language mastery has also been established (Brasel and Quigley, 1977; Crandall, 1978). The results of crossectional studies, which have a greater potential impact on classroom language instruction through MCE, are equivocal. While affirming the delayed mastery of inflectional MCE morphemes by 4-11 year old deaf students, these studies showed the need for longitudinal monitoring of broadly representative samples of MCE learners, comparative testing of deaf and hearing users of English

(preferably with the same instrument) and evaluation of component MCE skills, e.g., comprehension and production (Crandall, 1978; Raffin, David & Gelman, 1978; Zorfass, 1981). These kinds of data are necessary to resolve questions regarding classroom policies for MCE use such as whether full coding systems are more appropriately presented to younger or older deaf children (Bornstein, 1982).

This paper reports on a two-part longitudinal study of the English language competences of deaf students for whom TC through manual English was the primary method of instruction. The test instrument sampled a variety of grammatical features under each of three performance conditions. In Part I the performance of three groups of deaf subjects who used MCE was compared with that of three groups of normal hearing subjects who used oral English. In Part II a subset of subjects from the original deaf sample were retested three years later and these scores compared with their original scores.

It was hypothesized that if the English language competence of deaf children had been facilitated by TC programming through MCE, the evidence would be found in progressively increased control of English syntax during the early school years. Considering the recency of MCE implementation and the initial diagnostic lag experienced by a great majority of deaf children, the language performance of deaf children was not expected to equal that of hearing children. But, using patterns of performance produced by the hearing children as a reference, a more reasonable measure of the effectiveness of MCE would be improvement in the comparative performance of deaf children with increasing age.

Raffin et al. (1978) showed that, for deaf children, ages 6-11, judgment of the correctness of language samples was significantly better for subjects with longer exposure to MCE. Considering the confounding within the deaf population of age and time in school, measurement of the longitudinal contribution of time in an MCE program would have greater practical relevance. Multiple performance measures in the present study, in addition to providing a more specific evaluation of MCE competencies, would permit a preliminary assessment of the perceptual and communicative integrity of manually coded English as it is used by young deaf subjects.

Method

Subjects

Part I. Deaf subjects were selected on the following criteria: 1) average language ability relative to the deaf population, and average intellectual ability, 2) no identified learning or behavioral disorders, 3) severe to profound hearing loss at the speech frequencies (75 db ISO or greater, better ear), 4) prelingual onset of deafness and 5) attendance in a manual English program for a minimum of one year. In addition, the schools from which deaf subjects were selected were required 1) to have had a TC program, incorporating MCE, in effect for a minimum of three years at the time of the study, 2) to provide parental instruction in manual communication, and 3) to stipulate use of MCE in all activities and by all persons dealing directly with the deaf children.

A total of 39 deaf subjects in the three age ranges of 60-71 months (N=10), 72-83 months (N=15), and 84-95 months (n=14) were identified. These subjects represented all of the deaf children

meeting the above criteria at three large residential/day schools for the deaf. The schools were located in separate regions of the country and had similar MCE systems.

Demographic data for the groups of deaf subjects follows. Mean age in months for the youngest to oldest groups was 66.3, 77.8 and 89.7 months respectively. Mean age at onset of deafness could not be determined. It was reported to be "at birth" for 26 subjects, "infancy" (interpreted as 0-24 months) for 10 subjects, and at 16, 22, and 29 months for the three remaining subjects. The means and ranges of hearing loss in decibels were 97.9 (85-108) for the youngest group, 93.3 (75-110) for the middle age group, and 92.8 (75-108) for the oldest group. These included only three subjects, two in the middle and one in the oldest group, who had hearing losses in the 75-84 db range. The cause of deafness (bilateral, sensorineural) for most subjects was unknown; only five subjects had deaf parents or relatives. Length of attendance in a TC program expressed in means and ranges by groups was 27.3 (12-48 months) at the youngest age level, 33.6 (18-63 months) at the middle age level, and 38.9 (12-72 months) at the oldest age level. Group amplification systems were used by all children during school hours, and most also owned and used individual aids outside of the classroom.

In order to obtain a practical comparison of English language competencies between deaf and hearing subjects it was necessary to compensate somewhat for the lag in language exposure experienced by deaf children. Pilot testing had shown that orally trained deaf children (through age 7) were unable to perform on the study tasks and that age five was the youngest level at which MCE trained deaf

subjects could respond consistently. Specific age levels for corresponding groups of hearing subjects were determined by subtracting a language lag, estimated to be at least two years (Raffin, et al., 1978) from the age levels selected for deaf subject groups.

Hearing subjects were selected on the following criteria: 1) average language ability relative to the hearing population, along with average intellectual ability, and 2) no identified learning or behavioral disorders. In addition, the preschools from which hearing subjects were obtained were required 1) to provide a structured curriculum to supplement day care services, and 2) to include specific activities which involved the children in expressive language situations. These program stipulations were necessary to parallel the more formalized intervention programs of the deaf subjects.

Forty-five hearing subjects, 15 in each of three age levels, 36-47 months, 48-59 months and 60-71 months, were identified in two separate preschool programs. All hearing subjects met the above criteria. Mean age in months was 44.0 for the youngest group, 53.7 for the middle group, and 64.4 for the oldest group.

Part II. Fifteen deaf students, all of the subjects from one of the schools included in Part I, participated in the follow-up study. At the time of retesting, these subjects were aged 8, 9, or 10. Because of the reduced sample size the data were analyzed as a single treatment group.

Materials

Part I. This study employed a modified version of the Imitation, Comprehension and Production (ICP) test developed by Fraser, Bellugi and Brown (1963) to study syntactic performances of young normal children.

The ICP test, a comprehensive measure of basic language forms, can be used to compare linguistically distinct populations (Lovell and Dixon, 1967; Nurss and Day, 1979; Baird, 1972). This test was especially suitable because it isolates, by contrast, early-acquired features of English grammar and requires more than one type of performance to demonstrate competence. The features tested by the ICP account for a large proportion of the total English language errors produced by deaf children and adults. These also are the features that manual English specifically was designed to make available perceptually to the deaf.

Different random orders of a set of 48 test items were employed under three performance tasks: Imitation, Comprehension, and Production. Each test item was composed of "minimal pair sentences" differing only on the syntactic feature to be examined. The test set contains 12 subtests (4 items), each pertaining to the control of one syntactic feature: mass/count nouns, singular/plural third person present indicative, singular/plural with copula, present/past tense, present/future tense, affirmative/negative, active/passive voice, direct/indirect object, possessive pronouns, conjunctions, adjectives and prepositions.

The above list of subtests represents a modification of the content of the Fraser et al. (1963) test. Separate active and passive

voice subtests were combined to provide consistency in the overall contrast format. Pictures used with the Comprehension and Production tasks were those from the original passive voice subtest. Since control of conjunction had not been examined previously a subtest contrasting and/or was included. Vocabulary was chosen from among words already on the test, and pictures which duplicated the style of the original set were developed by a graphic artist. The remaining modifications involved only vocabulary choices. Eight of the words used in the original test did not have an MCE equivalent. Consequently the signed input would have been unnecessarily limited and the test perhaps made more difficult for the deaf subjects. Other words which could be signed and which were also among the list of words most commonly used by young children (Thorndike and Lorge, 1944) were substituted.

Part II. Materials used in part two of the study were the same as those described for part one.

Procedures

Part I. Prior to administering the tests the examiner visited the children at each school to establish rapport. For each of three testing sessions the subjects were taken individually to a quiet room away from the mainstream of activity. The order of task presentation was fixed: I then C then P. At the beginning of each task directions were given orally to all subjects with the addition of simultaneous MCE for the deaf subjects. Then warm-up items were presented to insure that directions had been understood.

For the Imitation task each hearing subject was presented with one test sentence (of a contrasted pair) at a time from an audio

cassette and then imitated what she or he had heard the examiner say. Each deaf subject had the test sentences presented one at a time by the examiner using MCE simultaneously with speech. Then the child imitated the examiner's performance. For the Comprehension task, each hearing subject was again presented with an order of the test sentences one at a time from the audio cassette. This time the child responded by pointing to that picture of a minimally distinctive pair which corresponded to each sentence. For deaf subjects the only difference was that the sentence presentation again involved MCE. Response procedures were the same as for hearing subjects. Another order of the same pictures (also alternated for left-right position) was used during the Production task. The examiner pointed to one picture at a time and the subject provided a sentence which told about that picture. This procedure was identical for hearing and deaf subjects except that responses of deaf subjects included signing.

On each task the rate of presentation was regulated by the subject's speed of response to the previous item. An item was repeated if a subject specifically requested a second presentation or if a subject indicated he/she had not perceived the stimulus. At least a half day separated administration of I and C measures and two days separated C and P measures. The responses of the subjects were scored live by the examiner and recorded on audio (hearing) and videotape (deaf) for corroboration at a later time.

Part II. The procedures used in part two of the study were the same as those described for part one.

Scoring

Part I. The scoring criteria as outlined in the original work (Fraser et al., 1963) were the basis for scoring responses in this study. Some adaptations were made in accordance with the modifications described earlier. [Passive voice required: noun + form of verb to be + verb with __ed. Conjunction required: noun + and or or + noun.] Each sentence pair was scored as one item which resulted in a possible score of 48 for each of the ICP tasks. If either or both sentences were incorrect the item received a score of zero. The few incomplete or unanswered items were scored as incorrect, because, in the examiner's judgment, these situations demonstrated not unwillingness but inability to produce the required responses. In evaluating responses of deaf subjects the complete oral and manual output was considered, i.e., on occasions subjects had signed but had not vocalized or vocalized in the absence of signing some portion of an utterance. This method of scoring individual responses was in keeping with the philosophy of "total communication" that all modalities be available for expression.

Three separate scores were obtained. On the Imitation task the child's sentences were scored with reference to the grammatical correctness of the repetition (as manifest in the contrasted features), disregarding any departures from the content vocabulary used (e.g., substituting "parrot" for "bird"). This discrimination was employed to assure that the subject's score reflected grammatical competence and not extraneous variables such as listening skills, speech idiosyncracies, or memory. The Production task was scored in much the same manner as the Imitation task. The performance criterion

involved grammatical contrast. Each subject had been required to produce spontaneously an appropriate sentence pair. Since the stimuli were pictures which had been matched previously to the paired verbal test items, the production responses were scored by comparison with the sentence models used for the Imitation and Comprehension tasks. Two scorers evaluated the responses of both hearing and deaf subjects on the Imitation and Production tasks. One scoring was done at the time of testing and the second utilized the audio or videotape recordings. Where discrepancies were encountered between these scorings, a third evaluation was performed to resolve the final score. The Comprehension test was scored on the correctness of the pictures chosen as referents for each sentence of the contrasted pair.

Part II. The scoring procedures used in part two of the study were the same as those described for part one.

Results

Part I Analyses. The experimental design for this portion of the study involved independent variables of hearing condition (HC; 2 levels) and age (3 levels each for hearing and deaf) and three dependent measures, Imitation, Comprehension and Production. The primary statistical procedure employed was multivariate ANOVA (SAS; Helwig and Council, 1979). A summary of the means, multivariate and univariate ANOVAs are presented in Table I. Means for each measure (I,C,P) are presented on the left with their associated univariate statistical tests on the right. Marginal means for each measure are also summarized, below, by hearing condition. Results of the multivariate ANOVA were significant as were the univariate ANOVAs for

HC, AGE, and HCxAGE on all measures (I,C,P) except for the HCxAGE interaction on Production.

To further examine the effects of prior language experience on ICP performances of deaf subjects, a multiple multivariate regression analysis was performed. For this analysis, age in months (AIM) and number of months time in an MCE program (TIP) were used as predictors of the three criterion measures I, C and P. To obtain the most conservative estimate of the contributions of these variables step down analyses were employed. Step down analyses test the influence of factors on some measure by removing the influence of other factors in an experimenter determined order (series of covariance tests; see Finn, 1974, pp. 156-160, 322-324). The order of the stepdown analyses paralleled the order of administration, that is, the order of removal of factors was I, C, P and for predictors was AIM and then TIP to obtain the most independent evaluation for TIP.

Results of these analyses can be found in Table 2. The ordering of tests is reflected in the table with the analysis at each level (criterion and predictor variables) having removed the influences of variables above that level.

These regression analyses revealed that AIM significantly predicted only I scores while TIP, with the influence of AIM removed, was a significant predictor of both I and P. Neither AIM nor TIP predicted C scores significantly.

Patterns of performance on the subtests of the ICP were analyzed through a Guttman Scaling procedure (SPSS; Nie, Hull, Jenkins, Steinbrenner and Bent, 1970). The analysis was done separately for hearing and deaf subtest data. The Guttman procedure is especially

appropriate since it first establishes that ordering of subtests which best fits the scaling characteristics of the data, and then tests the suitability of that ordering by means of four statistics. Acceptability levels for interpreting the statistics from this procedure were those suggested by Nie, et al. (1970) and appear in parenthesis. Coefficient of reproducibility (.90): hearing scale .86, deaf scale .89. Minimum marginal reproducibility (relatively low): hearing scale .77, deaf scale .78. Percent improvement (relatively high): hearing scale .09, deaf scale .11. Coefficient of scalability (.60): hearing scale .39, deaf scale .49. The hearing and deaf scales, developed from overall patterns of response to the ICP subtests, do not meet these Guttman criteria.

Table 3 contains the subtest order-of-difficulty rankings by hearing condition. Reading from least to most difficult, the lists present the total number of subjects failing and passing each subtest with all three tasks considered collectively.

Part II Analyses. The experimental design for this portion of the study involved the single independent variable of TIME (2 levels) and the three dependent measures, I, C and P. For the subset of subjects who participated in both parts of the study ICP scores from part one were compared with ICP scores obtained during part two. The statistical procedure employed was a multivariate ANOVA for repeated measurements. A summary of the means and multivariate statistics is presented in Table 4. Results of the multivariate ANOVA were significant as were the univariate ANOVAs for TIME on each measure.

Tests of the predictive value of AIM and TIP for the ICP performances of the deaf subjects in part two were conducted through

multiple, multivariate regression (step down) procedures. The ordering for tests was the same as in the Part I analyses. Results of these analysis showed that AIM was a significant predictor of Imitation score only and that TIP was not a significant predictor of any TIME 2 score. A summary of these statistical results is contained in Table 5.

In order to interpret these regression results, the same analysis was performed on the subset of part one data obtained from the deaf subjects who participated in part two. This multiple multivariate analysis revealed that AIM significantly predicted only the I scores of these subjects at time one. In contrast, TIP significantly predicted just the P scores. Neither AIM nor TIP predicted C scores. A summary of statistics for the analysis is also contained in Table 5.

The Guttman Scaling procedure was used to determine the ranked difficulty of ICP subtest performances by subjects in the second part of the study. Acceptability levels for interpreting the statistics were identical to those used in part one. This analysis showed the coefficient of reproducibility as .92, the minimum marginal reproducibility as .77, the percent improvement as .15 and the coefficient of scalability as .66. These results meet the Guttman criteria for a scalable order of difficulty.

As a further basis for interpretation of these Guttman results the same subtest analysis was conducted on the subset of part one ICP responses produced by the subjects who also participated in part two. Results of this analysis were: coefficient of reproducibility .88, minimum marginal reproducibility .79, percent improvement .09 and

coefficient of scalability .42. Levels for these scaling statistics were not sufficient to meet the Guttman criteria.

Table 6 contains the subtest order-of-difficulty rankings for deaf subjects as they responded to the original testing and to the follow-up. Reading from least to most difficult, the lists present the total number of subjects failing and passing each subtest with all three tasks considered collectively.

Discussion

The cumulative data from this study show clearly the deficits experienced by deaf students during the early stages of language acquisition. But the results also show the long-term improvement toward mastery of basic English grammatical features which is possible when students are provided with MCE in TC programs. The estimate of age compensation (thought to be conservative at two years) used in subject selection, in fact, underestimated the language differences between hearing and deaf. The data suggest that the difference, on this type of task, is closer to 3-4 years. The largest deficits occurred on the I task where the scores of deaf subjects was 13 to 20 points below those of younger hearing subjects. However, the average yearly improvement in I scores from ages 5 to 7 was 6-8 points and still near 4 points per year for the subjects three years later. Steady but slower rates of improvement are also evident for deaf subjects on the C and P tasks at all age levels in Part I, and continuing through Part II.

Results for Part I include significant interactions of age by hearing condition on two of the tasks, I and C. In the absence of interaction on the P task significant differences were found between

hearing conditions and among age groups. These P main effects have little practical significance. But the I and C results require further explanation. The interaction of variables on the I task can probably be attributed to a ceiling effect for the oldest group of hearing subjects. The sample of grammatical structures tested by the ICP consists of forms which are typically mastered by normal hearing subjects before school age, with the exception of passive voice which is ordinarily acquired later, so the scores of the oldest hearing subjects in this study were clustered understandably at a point where all but the most difficult features of the I test had been mastered.

The interaction of variables on the C task probably results from performance factors at the youngest age level. For the I and P tasks subjects had to produce complete and correct language strings to get a positive score. Here the redundancy of English grammar increases the complexity of these tasks. The C task, however, requires a simple pointing response to redundant cues contained in the stimulus [the DOG (sing.) digS (sing.)]. The deaf subjects, by virtue of their greater age, may have had a conceptual advantage over their linguistically superior but younger hearing counterparts. Thus, perhaps for different reasons, the youngest deaf subjects were able to use the redundant information to respond for this task on a level equal to the youngest hearing subjects. This initial advantage disappears with increasing age of the hearing subjects. Further, the interacting factors of age, conceptual ability and linguistic knowledge may explain the inability of either age-in-months or time-in-program to predict C scores of deaf subjects.

The early predictive significance of time in a TC program in contrast to its later nonsignificance reiterates the importance of early intervention with deaf children. Moreover, it supports the use of MCE, through Total Communication, as an effective intervention approach for these youngsters. Presently, it is not uncommon to find TC programming open to deaf children only in the presence of additional handicapping conditions or after learning has been unsuccessful in some other program (usually by the later primary years). Particularly noteworthy here is the value of TIP in predicting the quality of spontaneous language production prior to age seven. The small N for the Part II regression analysis may have contributed to the nonsignificant finding in the later years. However, the individual data do show a wide variability in later test scores as a function of TIP, suggesting that the same result would have occurred with a larger N.

The predictive power of AIM is strongly related to scores on the I task, whereas TIP was a significant predictor of I and P performance at young ages, but a nonsignificant predictor at later ages. For hearing subjects I performance was approaching ceiling by the age of five. The prediction of Imitation by AIM for deaf subjects throughout the primary grades may indicate a greater difficulty for manual imitation than for oral imitation. Processing demands for manual imitation may be excessive as a result of the necessity to switch from objective to subjective viewpoint during imitation. The predictive value of AIM for Imitation could be explained by developmental factors involved in mastery of perceptual-motor coordination, such as occurs with normal children on similar tasks (e.g., "Simon Says"). These

findings indicate the need to examine more intensively the issue of manual language processing (especially of a detailed code such as MCE) by very young deaf children, and the ways in which component skills are addressed in preschool curricula.

The Guttman Scaling results show the establishment over time of a clear pattern of difficulty in the acquisition of the ICP's twelve grammatical features by deaf subjects. Comparison of the deaf and hearing scales from Part I shows that certain grammatical forms (e.g., Affirm/Negative) are relatively easy for both types of subjects while others (e.g., Dir./Ind. object) are difficult for both. Still other forms are comparatively easier for either the hearing (e.g., Pres./Past) or the deaf (e.g., Mass/Count) subjects while ranking as more difficult for the other subject group. In some instances the explanation may lie in conceptual versus linguistic difficulty of the language feature. The mass/count contrast involves simple form requirements yet a rather sophisticated conceptual distinction. Past tense is not very difficult conceptually but its linguistic contrast with present tense required the production of redundant grammatical morphemes (is__ing/__ed). The coexisting advanced conceptual ability and retarded language ability of the deaf subjects as compared to the hearing subjects in this study may be the source of such differences between the groups regarding the relative difficulty of grammatical features. Since neither the hearing nor deaf results were scalable more definitive conclusions are not possible.

Guttman Scales are considered to be unidimensional and cumulative so that a scalable ranking might be said to represent an acquisition order. The subtest ranking of difficulty for the deaf subjects in

Part II was scalable. This result is important because the scale produced by this subset of subjects on Part I, though different from that of the entire deaf sample, still was not scalable. In other words, while the pattern of language competencies for these deaf students varied widely and unpredictably at ages 5 through 7, by the time they completed the primary grades a pattern of competencies in basic English grammar, as measured by the ICP, was firmly established. Some of the changes in order over time, e.g., improvement in sing/PJ-Is/Are may be indicative of particular content instruction which occurred in the interim. The scope of this study does not permit an explanation of the processes by which the eventual ordering was attained. However, there is reason to be concerned about features which consistently appear at the bottom of such rankings and on which little to no improvement is noted. Knowledge of some forms (e.g., negative, mass, count, possessives) may develop naturally out of everyday interactions in MCE. Other forms may not be expected to develop in this way, especially if persons interacting with the children are only marginally competent in MCE or if the forms themselves have simpler or shortened alternatives (e.g., active for passive voice). Acquisition of more difficult forms may require changes in present MCE coding of these forms (e.g., present indicative ___s distinct from plural ___s). It may also be necessary to alter implementation procedures or accompanying formal language instruction for young MCE learners to insure adequate and earlier exposure to difficult forms (e.g., parallel use of active and passive forms in discussions during ongoing preschool activities). In conclusion, it appears from the results of the two part study that the process of

acquiring competencies in English through a manual code under TC programming can work but that caution needs to be exercised regarding the breadth of content that is assumed to be available within the child's MCE environment.

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TABLE 1

PART I

Summary of Means and MANOVA Analyses

MEANS

UNIVARIATE TESTS[+]

Imitation

HC	AGE (H/D) 3/5	4/6	5/7	
Hearing	34.5	40.0	41.2	38.6
Deaf	12.8	19.6	26.3	21.0
	25.8	29.8	35.0	30.4

Effect	df	MS	F	p
HC	1	6916.9	172.36	.0001
AGE	2	805.2	20.06	.0001
HCxAGE	2	156.8	3.91	.0242
error	78	40.1		

Comprehension

HC	AGE (H/D) 3/5	4/6	5/7	
Hearing	23.5	33.0	35.4	30.6
Deaf	24.4	25.5	27.8	26.0
	23.4	29.3	31.6	28.5

Effect	df	MS	F	p
HC	1	475.2	19.44	.0001
AGE	2	384.5	15.73	.0001
HCxAGE	2	154.7	6.33	.0021
error	78	24.4		

Production

HC	AGE (H/D) 3/5	4/6	5/7	
Hearing	8.9	13.7	15.9	12.9
Deaf	3.3	5.3	8.8	6.0
	6.7	9.5	12.5	9.7

Effect	df	MS	F	p
HC	1	1030.5	37.52	.0001
AGE	2	255.5	9.31	.0002
HCxAGE	2	13.4	.49	.61
error	78	27.5		

Summary

	Imit.	Comp.	Prod.
Hearing	38.6	30.6	12.9
Deaf	21.0	26.0	6.0

Multivariate Test (Pillai's Trace)

HC	3,76	56.0	.0001
AGE	6,154	6.87	.0001
HC x AGE	6,154	4.37	.0004

[+]based on SAS Type IV sums of squares

TABLE 2

PART I
Regression Analysis with Age in Months and Time in Program
As Predictors of ICP Scores

AIM and TIP Combined as Predictors of ICP

	Univariate			Stepdown		
Source	MS	F	p	MS	F	p
Imit.		22.80	.0001	991.37	22.808	.0001
Comp.		1.70	.1976	.71	.023	.9781
Prod.		20.00	.0001	22.97	3.080	.0600

AIM As A Predictor of ICP

Overall Multivariate ($F(3,35) = 9.83$, $p = .0001$

Source	MS	F	p	MS	F	p
Imit.	1544.3	28.5	.0001	1544.00	28.50	.0001
Comp.	77.5	2.5	.1200	.06	.00	.9630
Prod.	252.6	30.7	.0001	11.50	1.40	.2400

TIP As A Predictor of ICP

Overall Multivariate ($F(3,34) = 5.71$, $p = .0028$

Imit.	438.4	10.10	.0030	438.40	10.10	.003
Comp.	30.6	.96	.3300	.04	.00	.970
Prod.	124.9	13.21	.0009	34.47	4.62	.039

TABLE 3

Part I

Rank Orders of Difficulty for ICP Subtests by Hearing Condition

Hearing		Deaf	
Contrast Order	(Fail,Pass)	Contrast Order	(Fail, Pass)
Affirm/Negative	(1, 44)	Affirm/Negative	(5, 34)
Preposition	(3, 42)	Mass/Count	(14, 25)
Pres/Past	(7, 38)	Possessive	(20, 19)
Adjective	(8, 37)	Preposition	(24, 15)
Pres/Future	(10, 35)	Conjunction	(27, 12)
Sing/Pl-Is/Are	(11, 34)	Pres/Future	(29, 10)
Possessive	(13, 32)	Adjective	(30, 9)
Act./Passive	(15, 30)	Sing/Pl-Is/Are	(31, 8)
Mass/Count	(15, 30)	Pres/Past	(32, 7)
Conjunction	(17, 28)	Sing/Pl-Pres. Ind.	(37, 2)
Sing/Pl-Pres. Ind.	(31, 14)	Act/Passive	(38, 1)
Dir/Ind Object	(34, 11)	Dir/Ind Object	(39, 0)

Table 4

Part II

Analysis of ICP Performance of Deaf Subjects Over Time

	Means TIME 1	2		Univariate Analyses Source	DF	MS	F	p
Imitation	23.4	34.6	29.0	Time	1	940	6.19	.05
				Residual	14	152		
Comprehension	24.9	34.0	29.47	Time	1	616.53	16.00	.01
				Residual	14	38.53		
Production	7.1	17.1	12.17	Time	1	750.00	12.53	.01
				Residual	14	59.84		

Multivariate Analysis (Pillai's Trace)

Time, overall	3,12	16.00	.0002

TABLE 5

Part II

TIME 1

AIM and TIP Combined As Predictors of ICP

	Univariate			Stepdown		
Source	MS	F	p	MS	F	p
Imit.	407.37	10.34	.0025	407.37	10.34	.0025
Comp.	47.49	1.06	.3783	44.33	.91	.75
Prod.	77.71	8.84	.0044	17.32	3.19	.90

AIM As a Predictor of ICP

Overall Multivariate F(3,11) = 6.54, p = .0084

Source	MS	F	p	MS	F	p
Imit.	808.12	21.91	.0004	808.15	21.91	.0004
Comp.	32.31	.70	.4189	22.14	.44	.518
Prod.	110.46	9.54	.0086	.005	.00	.981

TIP As A Predictor of ICP

Overall Multivariate F(3,10) = 2.89, p = .088

Source	MS	F	p	MS	F	p
Imit.	6.64	.17	.689	6.64	.17	.689
Comp.	62.66	1.39	.261	66.53	1.37	.266
Prod.	44.97	5.11	.043	34.63	6.38	.030

TIME 2

AIM and TIP Combined As Predictors of ICP

	Univariate			Stepdown		
Source	MS	F	p	MS	F	p
Imit.	220.6	3.53	.06	220.60	3.53	.06
Comp.	47.9	2.39	.14	11.18	.64	.75
Prod.	109.7	2.15	.16	4.84	.35	.75

AIM As a Predictor of ICP

Overall Multivariate F(3,11) = 2.48, p = .1158

Source	MS	F	p	MS	F	p
Imit.	441.3	7.65	.016	441.3	7.65	.016
Comp.	82.7	4.24	.060	9.1	.53	.481
Prod.	214.0	4.50	.054	1.5	.11	.742

TIP As A Predictor of ICP

Overall Multivariate F(3,10) = 1.53, p = .2663

Source	MS	F	p	MS	F	p
Imit	.004	.00	.99	.004	.00	.99
Comp.	13.150	.66	.43	13.300	.76	.40
Prod.	5.380	.10	.75	8.170	.59	.46

TABLE 6

Part II
Rank Orders of Difficulty for ICP Subtests by
Deaf Subjects Over Time

Time 1		Time 2	
Contrast Order	(Fail, Pass)	Contrast Order	(Fail, Pass)
Affirm/Negative	(1, 14)	Affirm/Negative	(0, 15)
Mass/Count	(5, 10)	Possessive	(1, 14)
Possessive	(7, 8)	Mass/Count	(1, 14)
Preposition	(10, 5)	Adjective	(3, 12)
Pres/Future	(10, 5)	Pres/Future	(3, 12)
Adjective	(11, 4)	Sing/Pl-Is/Are	(3, 12)
Conjunction	(12, 3)	Preposition	(5, 10)
Pres/Past	(12, 3)	Pres/Past	(5, 10)
Sing/Pl-Is/Are	(12, 3)	Conjunction	(7, 8)
Act/Passive	(14, 1)	Act/Passive	(7, 8)
Sing/Pl-Pres. Ind.	(14, 1)	Sing/Pl-Pres. Ind.	(9, 6)
Dir/Ind Object	(15, 0)	Dir/Ind Object	(15, 0)